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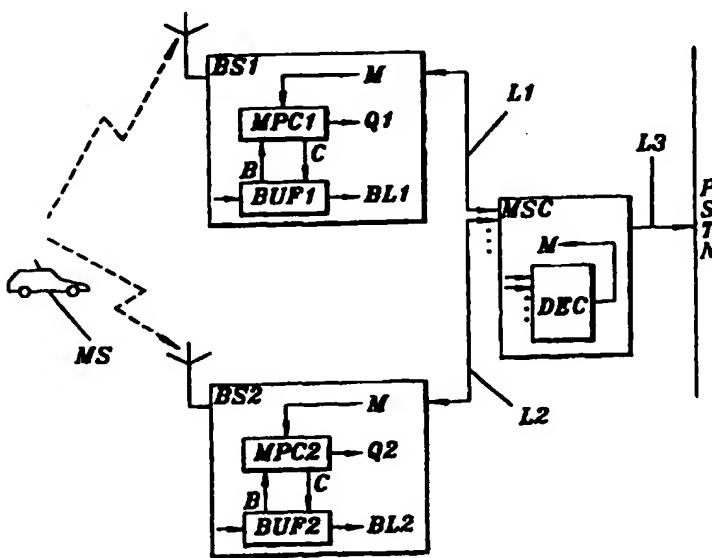
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(54) Title: UP LINK MACRO DIVERSITY METHOD AND APPARATUS IN A DIGITAL MOBILE RADIO COMMUNICATION SYSTEM



(57) Abstract

A digital cellular mobile radio communication system comprises a mobile station (MS) transmitting an information block and a set of base stations (BS1, BS2) receiving information blocks (BL1, BL2) corresponding to said transmitted information block at each base station in said set. This communication system contains an up link macro diversity system with means (MPC1, MPC2) in each base station (BS1, BS2) for determining a quality measure (Q1, Q2) representing the reliability of each respective received information block (BL1, BL2), and decision means (DEC) for choosing the received information block (BL1, BL2) with the best quality measure as a common output information block of said set of base stations (BS1, BS2).

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UP LINK MACRO DIVERSITY METHOD AND APPARATUS IN  
A DIGITAL MOBILE RADIO COMMUNICATION SYSTEM

TECHNICAL FIELD

The present invention relates to macro diversity in a digital mobile radio communication system, and in particular to an up link macro diversity method and apparatus in such a system.

BACKGROUND OF THE INVENTION

In conventional digital cellular mobile radio communication systems a mobile station communicates with only one base station at each given time. However, recently it has been suggested to use so called macro diversity in such systems. This concept means that in the down link direction several base stations send the same information blocks to a mobile station, which combines the sent blocks into a final received block. In the up link direction a mobile station transmits an information block which is received at several base stations. The received blocks are transmitted to a common node in the land system, for example a mobile services switching center, where the received blocks are combined into a final received block. These procedures increase the reliability of the received information blocks, since the information has now travelled along different paths, one of which may distort the information less than the other.

A drawback of these up link diversity methods is that the received information blocks from several base stations have to be sent to the mobile services switching center, which reduces the capacity of the land system.

SUMMARY OF THE INVENTION

An object of the present invention is therefore to provide an up link macro diversity method and apparatus in a digital cellular mobile radio communication system in which the capacity of the

land system is increased by reducing the amount of information that has to be transferred between base stations and the next node of the land system of said communication system, for example a mobile services switching center.

5 One way to combine information blocks from several base stations is to use only the information from the "best" block. In such a case it would be unnecessary to transfer the information of discarded blocks between base stations and the mobile services switching center. Thus, the present invention is based on the  
10 idea that instead of transferring all the received blocks, it is sufficient to calculate a quality measure for each block and to transfer only these quality measures. The quality measures received by the mobile services switching center are then compared, and the base station from which the best quality  
15 measure was received is ordered to transfer its information block.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by making reference to the  
20 following description taken together with the accompanying drawings, in which:

FIGURE 1 is a block diagram of a part of a digital cellular mobile radio communication system illustrating the concepts of the present invention;

25 FIGURE 2 is a diagram illustrating the signal transfer between base stations and a mobile services switching center operating in accordance with the present invention; and

30 FIGURE 3 is a flow chart illustrating the method in accordance with the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described with reference to a digital cellular radio communication system of TDMA type. However, the invention is not restricted to such systems, but is 5 also applicable to other digital cellular systems, such as CDMA systems.

In Figure 1 a mobile MS transmits information blocks, which are received at two base stations BS1 and BS2. The received signals are demodulated and decoded in accordance with conventional 10 methods, and the resulting information blocks BL1 and BL2, respectively, are stored in respective buffers BUF1 and BUF2. In a preferred embodiment an information block is a frame, which typically corresponds to 10-40 ms of speech/data. Microprocessor controllers MPC1 and MPC2, respectively, retrieve relevant bits over bit retrieval lines B for calculating and outputting 15 corresponding quality methods Q1 and Q2, respectively, of the stored blocks BL1 and BL2.

Here the concept quality measure does not necessarily mean just a single value, but could imply a sequence of values representing 20 different aspects of the quality of the respective received block.

Examples of suitable quality measures are the number of bytes in a block that contained an error that was correctable, the number 25 of bytes that contain non-correctable errors, or a combination thereof. Another quality measure is described in WO-94/05100, according to which a channel estimate is used to form a quality measure.

The quality measures Q1, Q2 are sent on respective lines L1, L2 30 to the mobile services switching centers MSC, which contains a decision means DEC that receives these signals. Decision means DEC may for instance comprise a micro processor. The dots below line L2 and below the input lines of decision means DEC imply

that quality measures may be received from more than two base stations. In fact in its most general form the invention implies receiving quality measures Q<sub>1</sub>, Q<sub>2</sub>, ..., Q<sub>N</sub> from a set of corresponding base stations BS<sub>1</sub>, BS<sub>2</sub>, ..., BS<sub>N</sub>.

5 Decision means DEC determines the best received quality measure and sends a message M to the microprocessor controller in the corresponding base station BS<sub>1</sub> or BS<sub>2</sub> over corresponding line L<sub>1</sub> or L<sub>2</sub>. The microprocessor controller that receives this message, over a line C instructs its buffer to output its block (BL<sub>1</sub> or BL<sub>2</sub>) to mobile services switching center MSC. On the corresponding output line (L<sub>1</sub> or L<sub>2</sub>). The block received by mobile services switching center MSC is considered as the common output block from all the base stations in the set.

15 The above procedure is further illustrated in Figure 2. Here quality measures Q<sub>1</sub> and Q<sub>2</sub> are received by mobile services switching center MSC from the base stations BS<sub>1</sub> and BS<sub>2</sub>, respectively. The decision means in mobile services switching center MSC determines that Q<sub>2</sub> is the best measure, which implies that block BL<sub>2</sub> is the most reliable block. Therefore mobile service switching center MSC sends message M to base station BS<sub>2</sub>, in which microprocessor controller MPC<sub>2</sub> instructs buffer BUF<sub>2</sub> to output block 2 to mobile services switching center MSC, which in turn outputs block BL<sub>2</sub> on line L<sub>3</sub> to the public switched telephone network PSTN (see Figure 1) as a common output from base stations BS<sub>1</sub>, BS<sub>2</sub>.

20 In the above description it has been assumed that lines L<sub>1</sub>, L<sub>2</sub> are used for signalling (Q<sub>1</sub>, Q<sub>2</sub>, M) as well as information transfer (BL<sub>1</sub>, BL<sub>2</sub>). However, in practice there may be separate lines for signalling and information transfer.

25 30 Figure 3 is a flow chart illustrating the above described method. The routine starts in step 300. In step 310 the measures Q<sub>1</sub>, Q<sub>2</sub>, ..., Q<sub>N</sub> of the received information blocks are calculated at each base station BS<sub>1</sub>, BS<sub>2</sub>, ..., BS<sub>N</sub> in the set. In step 320 the set

of quality measures  $Q_1, Q_2, \dots, Q_N$  are sent to decision means DEC. In step 330 decision means DEC determines the best measure  $Q$ . In step 340 the base station that corresponds to the block with the best  $Q$  is instructed to output its block as a common output from the entire set of base stations. Finally the routine ends in step 350. This routine is repeated for each information block that is transmitted from the mobile station MS and received by the base stations in the set.

In the above described embodiment it has been assumed that decision means DEC is located in a mobile services switching center. However, this is not necessarily the case, since decision means DEC does not actually process any received information blocks, it only receives quality measures, determines the best measure and instructs a corresponding base stations to output its block. Therefore decision means DEC may be physically separated from mobile services switching center MSC. However, the actually transferred information blocks from base stations BS1, BS2 will be sent to mobile services switching center MSC.

In the above description it has also been assumed that only one information block is chosen from a set of received information blocks. However, it is within the scope of the same inventive idea to form (in element DEC in Fig. 1, for example) a combination of the best (in terms of quality measure) received blocks as a common output from a set of base stations. This would still reduce the amount of signaling, since not all received blocks have to be transferred to the mobile services switching center. For example, if the 3 best received blocks are transferred to the mobile services switching center, a combined block may be formed by setting each bit in this block equal to the value of the majority of the 3 corresponding transferred bits.

Furthermore, in this specification the present invention has been described with reference to a TDMA system. However, as noted above the invention is also applicable to a CDMA system.

It will be understood by those skilled in the art that various modifications and changes may be made to the present invention without departure from the spirit and scope thereof, which is defined by the appended claims.

## CLAIMS

1. An up link macro diversity method in a digital cellular mobile radio communication system, comprising the steps of transmitting an information block from a mobile station and receiving information blocks corresponding to said transmitted information block at each base station of a predetermined set of base stations, said method being characterized by the further steps of:

determining, at each base station in said set, a quality measure representing the reliability of each respective received information block;

choosing the information block with the best quality measure as a common output information block of said set of base stations.

2. The method of claim 1, characterized by the further steps of: sending the quality measure from each base station to a decision means;

determining the best quality measure in said decision means; and

ordering the base station corresponding to the best quality measure to output its received information block as said common output information block.

3. An up link macro diversity method in a digital cellular mobile radio communication system, comprising the steps of transmitting an information block from a mobile station and receiving information blocks corresponding to said transmitted information block at each base station of a predetermined set of base stations, said method being characterized by the further steps of:

determining, at each base station in said set, a quality measure representing the reliability of each respective received information block;

combining some received information blocks having the best quality measures into a common output information block of said

set of base stations.

4. An up link macro diversity system in a digital cellular mobile radio communication system, comprising a mobile station transmitting an information block and a set of base stations receiving information blocks corresponding to said transmitted information block at each base station in said set, said diversity system being characterized by:

means (MPC1, MPC2) in each base station (BS1, BS2) of said set for determining a quality measure (Q1, Q2) representing the reliability of each respective received information block (BL1, BL2);

decision means (DEC) for choosing the received information block (BL1, BL2) with the best quality measure as a common output information block of said set of base stations (BS1, BS2).

5. The diversity system of claim 4, characterized by said decision means (DEC) being connected to each base station (BS1, BS2) in said set for receiving said quality measures, determining the best quality measure and ordering the base station corresponding to the best quality measure to output its received information block as said common output information block.

6. The diversity system of claim 6, characterized by said decision means (DEC) being provided in a mobile services switching center (MSC).

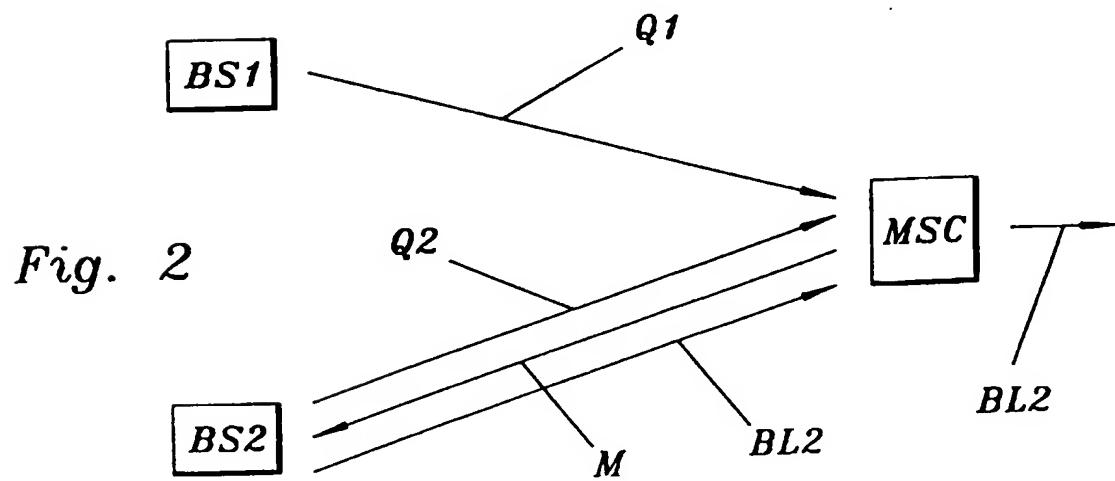
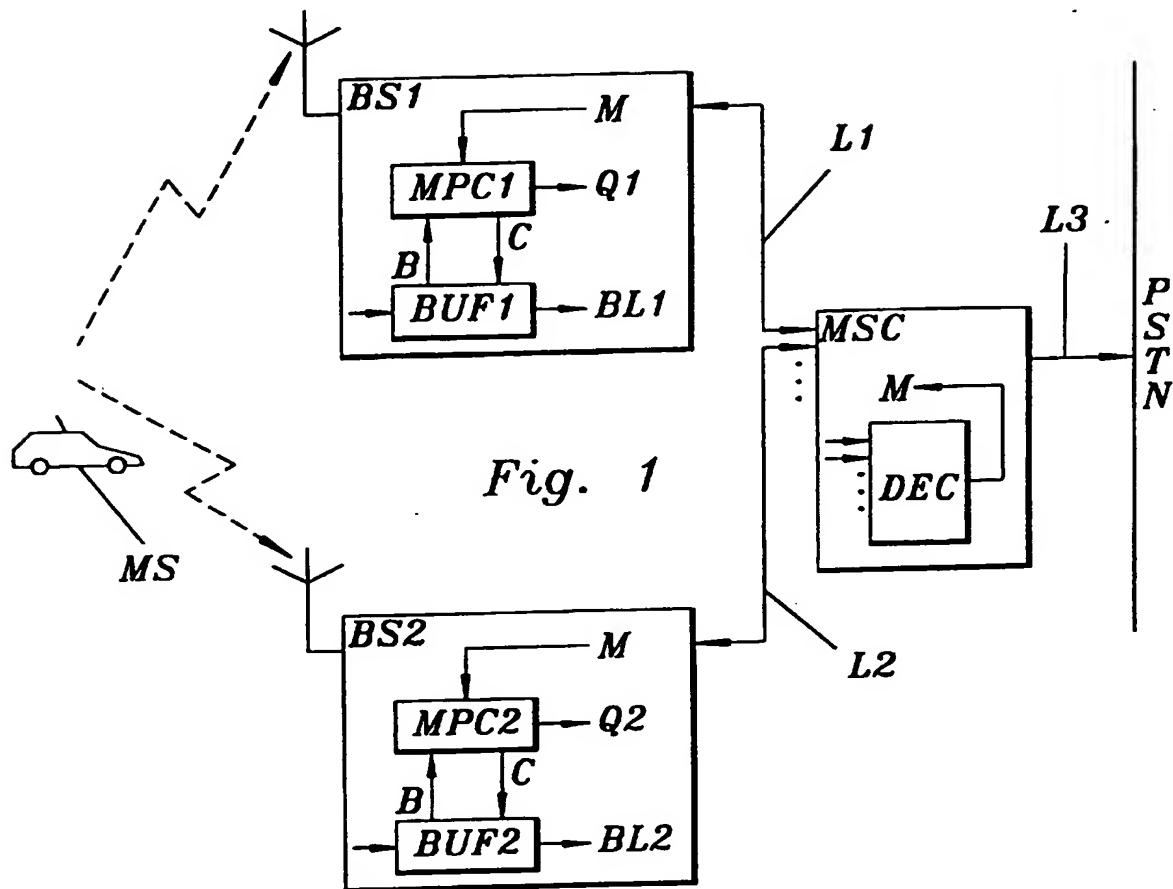
7. An up link macro diversity system in a digital cellular mobile radio communication system, comprising a mobile station transmitting an information block and a set of base stations receiving information blocks corresponding to said transmitted information block at each base station in said set, said diversity system being characterized by:

means (MPC1, MPC2) in each base station (BS1, BS2) of said set for determining a quality measure (Q1, Q2) representing the reliability of each respective received information block (BL1, BL2);

means (DEC) for combining some received information blocks (BL1, BL2) having the best quality measures into a common output information block of said set of base stations (BS1, BS2).

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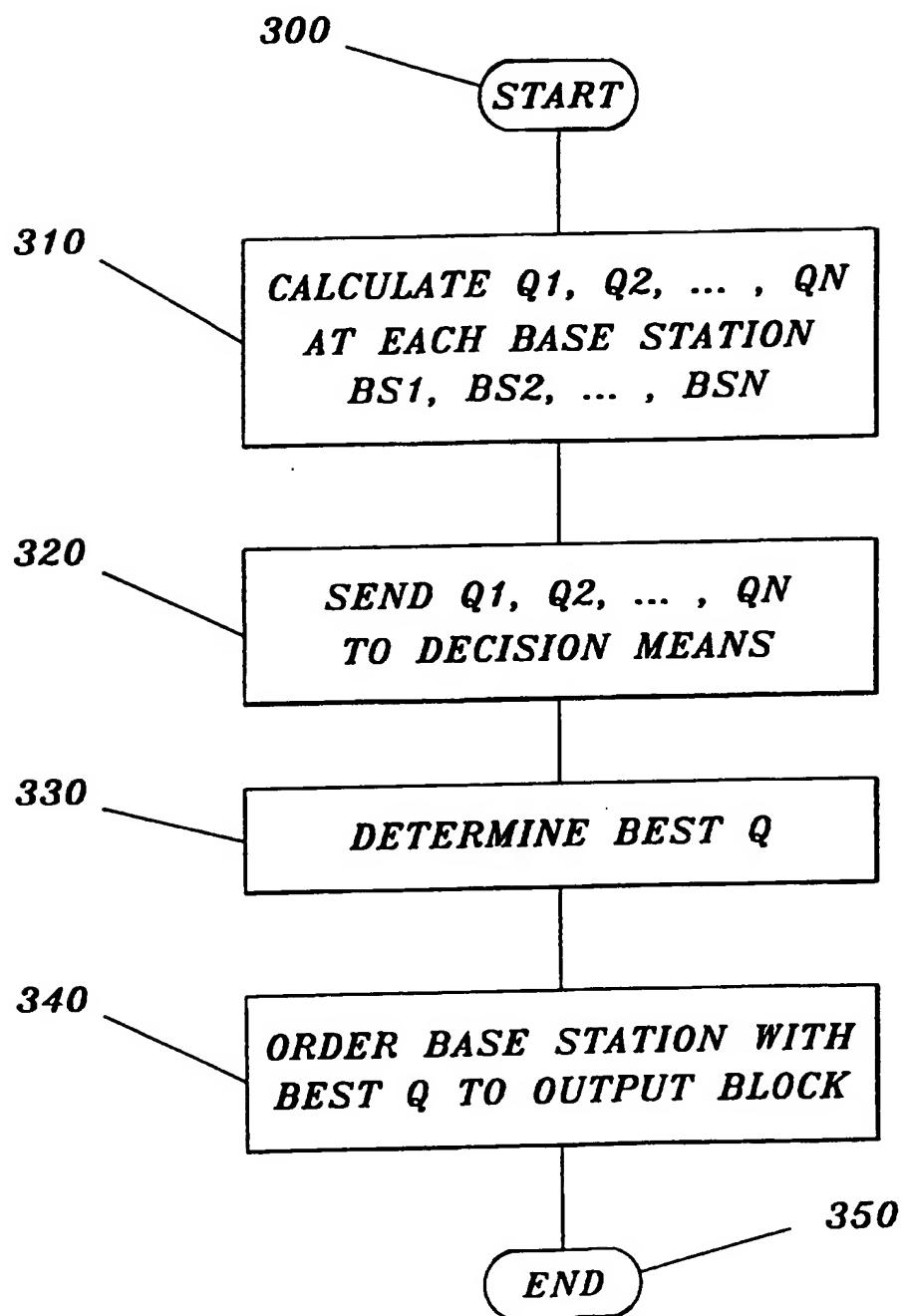


Fig. 3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/01396

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/38

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04B, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO 9504419 A1 (BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY), 9 February 1995 (09.02.95), page 1, line 35 - page 2, line 37; page 5, line 29 - line 34; page 8, line 8 - line 9, page 8, line 32 - line 35 --	1-7
A,P	EP 0643542 A1 (SIEMENS AKTIENGESELLSCHAFT), 15 March 1995 (15.03.95), see whole document --	1-7
A	WO 9319537 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 30 Sept 1993 (30.09.93), page 8, line 27 - page 9, line 8; page 15, line 4 - line 21; page 17, line 1 - line 10 --	1-7

 Further documents are listed in the continuation of Box C. See patent family annex.

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

05/02/96

International application No. PCT/SE 95/01396	
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A1- 9504419	09/02/95	NONE	
EP-A1- 0643542	15/03/95	NONE	
WO-A1- 9319537	30/09/93	AU-B- 659308 AU-A- 3910893 BR-A- 9305449 CA-A- 2109114 EP-A- 0586681 FI-D- 935194 JP-T- 6508492 NZ-A- 251478	11/05/95 21/10/93 11/10/94 25/09/93 16/03/94 00/00/00 22/09/94 21/12/95